

WHAT IS CLAIMED IS:

1. A fuel processor for the production of hydrogen from a hydrocarbon fuel, comprising:
 - (a) a reactor for the production of hydrogen-containing reformat using an oxidant, water and hydrocarbon fuel; and
 - (b) a water transfer device that transfers water vapor from the reformat produced by said reactor to a reactant used by said reactor, comprising a water-transfer membrane.
2. A fuel processor according to Claim 1, wherein said reactant is air.
3. A fuel processor according to Claim 2, wherein said air is at a temperature less than about 50°C.
4. A fuel processor according to Claim 3, wherein said air is at about ambient temperature.
5. A fuel processor according to Claim 1, wherein said water transfer membrane comprises poly[perfluorosulfonic] acid.

6. A fuel processor for the production of hydrogen from a hydrocarbon fuel, comprising:
- (a) a reactor having a reactant input, and a reformat output; and
 - (b) a water transfer device comprising (i) a transfer device input connected to said reformat output of the reactor, (ii) a transfer device output connected to said reactant input of the reactor, and (iii) a water-transfer membrane; wherein said water transfer device transfers water from said reformat output to said reactant input.
7. A power plant fuel processor according to Claim 5, wherein said reactant input of the reactor is an oxidant input.
8. A power plant fuel processor according to Claim 6, wherein said reactor is an autothermal reactor.
9. A power plant according to Claim 6, further comprising a compressor having a reactant input and that supplies an output of compressed reactant to said reactant input of the reactor, wherein said water transfer device transfers water vapor to said reactant input of the compressor.
10. A power plant fuel processor according to Claim 7, wherein said reactant input of the reactor is an oxidant input.

11. A power plant according to Claim 8, wherein said water transfer device comprises an input for air at a temperature of less than about 50°C.
12. A power plant according to Claim 11, wherein said water transfer device additionally comprises an input for air at about ambient temperature.
13. A power plant fuel processor according to Claim 6, wherein said membrane comprises poly[perfluorosulfonic] acid.
14. A method for humidifying a reactant for a fuel processor that makes a hydrogen-containing reformat, comprising the transfer of water vapor from said reformat to said reactant using a water transfer device comprising a water transfer membrane.
15. A method for humidifying a reactant according to Claim 14, wherein said reactant is air.
16. A method for humidifying a reactant according to Claim 15, wherein said air is at a temperature of less than about 50°C when it is humidified by said water transfer device.

17. A water transfer device for the transfer of water vapor from a primary gas to a secondary gas in a fuel cell power plant, having a primary gas inlet, a primary gas outlet, a secondary gas inlet and a secondary gas outlet, comprising:

- (a) a primary gas inlet;
- (b) a primary gas outlet;
- (c) a secondary gas inlet;
- (d) a secondary gas outlet;
- (e) a conduit having an inner void and outer surface, the walls of which comprise a water transfer membrane material, wherein one end of said conduit is connected to said primary gas inlet, and the other end of said conduit is connected to said primary gas outlet so as to allow for the flow of a primary gas through said inner void; and
- (f) a housing which encloses and provides a void space around at least a portion of the outer surface of said conduit, wherein said housing has a secondary gas inlet and a secondary gas outlet allowing for the flow of a secondary gas through said void space; wherein secondary gas flowing through the void space of said housing passes over an outer surface of said conduit, but does not substantially mix with primary gas flowing through the inner void of said conduit.

18. A water transfer device according to Claim 17, comprising a plurality of said conduits, all of which are connected to said primary gas inlet and said primary gas outlet.

19. A water transfer device according to Claim 17, wherein said water transfer membrane material comprises a poly[perfluorosulfonic] acid.

20. A water transfer device according to Claim 19, wherein the direction of said flow of primary gas is in essentially the opposite direction of the said flow of said secondary gas.

21. A method for humidifying a reactant for a fuel processor using a water transfer device according to Claim 17.

22. A method for humidifying a reactant for a fuel processor according to Claim 21, wherein said primary gas inlet is supplied with reformat produced by a reactor, and said secondary gas inlet is supplied with air, comprising transferring of water vapor from said reformat to said air using said water transfer device, and supplying said air from said secondary gas outlet to a reactor in said fuel processor.

23. A method for humidifying a reactant for a fuel processor according to Claim 22, wherein the temperature of said air is less than about 50°C, and the pressure of said reformat is from about 170% to about 270% of the pressure of said air.

24. A fuel processor according to Claim 1, wherein said water transfer device comprises:

- (a) a reformat gas inlet connected to the reformat stream outlet of said reactor;
- (b) a reformat gas outlet;
- (c) an oxidant gas inlet;
- (d) an oxidant gas outlet;
- (e) a conduit having an inner void and an outer surface, the walls of which comprise a water transfer membrane material, wherein one end of said conduit is connected to said reformat gas inlet, and the other end of said conduit is connected to said reformat gas outlet so as to allow for the flow of hydrogen gas through said inner void; and
- (f) a housing which encloses and provides a void space around at least a portion of the outer surface of said conduit, wherein said housing has an oxidant gas inlet and an oxidant gas outlet allowing for the flow of an oxidant gas through said void space; wherein the oxidant gas flowing through said void space in the housing passes over said conduit, but does not substantially mix with the hydrogen gas flowing through said inner void of the conduit.